

# PATENT ABSTRACTS OF JAPAN

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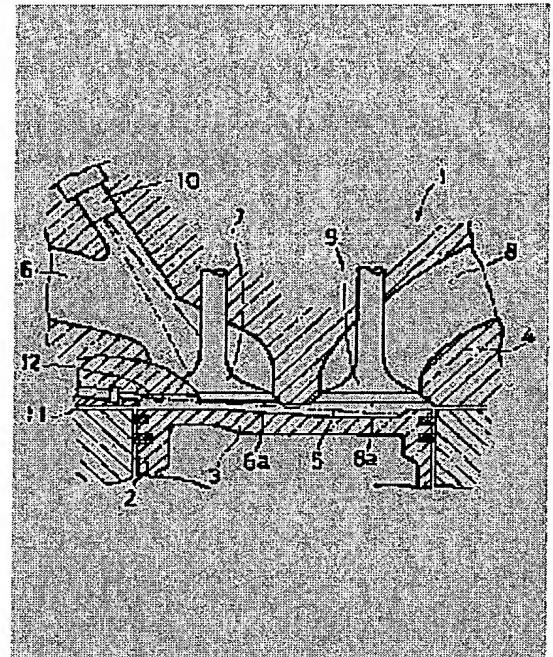
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## (54) INTERNAL COMBUSTION ENGINE AND START OF COMBUSTION CONTROL METHOD

### (57) Abstract:

**PROBLEM TO BE SOLVED:** To smoothly complete the combustion with a lean air fuel ratio, by forming an air-fuel mixture of high temperature and high pressure in a combustion chamber, and using a laser source outputting the laser beam of which the wavelength is an excitation band of almost OH gp or CH gp, as a combustion starting means for combusting the air-fuel mixture.

**SOLUTION:** The air-fuel mixture which is premixed by jetting the fuel from an injector 10, is introduced to a cylinder 2, a piston 3 is risen, and the air-fuel mixture is compressed to obtain a high temperature and high pressure condition, and the fuel is decomposed into the molecules of low molecular weight, including OH gp and CH gp by cracking. The compression ratio on this occasion, is determined so that the temperature of the air-fuel mixture in the compression top dead center is adjusted to be lower than the self-ignition temperature, that is, the temperature free from the self-ignition. The laser beam of about 310nm of wavelength is irradiated from a laser source 11 into a combustion chamber 11 immediately after the compression dead point, for exciting the OH gp in the air-fuel mixture to generate a large amount of OH radical. Thereby the chain reaction of the combustion is immediately and simultaneously started on the multipoints for combusting the air-fuel mixture.



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## DETAILED DESCRIPTION

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### [Detailed Description of the Invention]

[0001]

[The technical field to which invention belongs] Especially this invention relates to the internal combustion engine equipped with the combustion start means by the laser beam, and its combustion start control method about an internal combustion engine.

[0002]

[Description of the Prior Art] By premixing and introducing inhalation of air and fuel in the conventional usual gasoline internal combustion engine if needed in the cylinder divided with the cylinder head and the piston, and compressing by upper \*\* of a piston Complete fuel injection earlier enough than an ignition stage, and the gaseous mixture of elevated-temperature high pressure by which air was mixed comparatively homogeneously with fuel at the ignition stage is formed. Light by jump spark ignition with an ignition plug near the compression edge, it is made to complete combustion of a gaseous mixture because a flame spreads a combustion chamber with the ignition as the starting point, and pressure generating is controlled by ignition timing.

[0003] Moreover, while carrying out direct injection of the fuel into a cylinder near the compression edge with a piston, what carries out jump spark ignition with an ignition plug is proposed.

[0004] Moreover, if realizable by proposing the premixing autohesion fire internal combustion engine of a high compression ratio which premixes fuel, and forms a homogeneous gaseous mixture, and was made to carry out autohesion fire combustion at a compression edge as indicated by JP,7-332141,A etc., for example, even if an air-fuel ratio is thin, combustion is completed all at once by multipoint ignition, a mpg performance is high and a low (about 10 ppm), and efficient and a low emission engine are obtained very much for NOx eccrisis concentration.

[0005]

[Problem(s) to be Solved by the Invention] However, there is a problem that ignition stability falls as the gas of an end burns and remains or an air-fuel ratio becomes thin, since it is flame propagation combustion from one by jump spark ignition, although the fall of combustion temperature and thin air-fuel ratio combustion are effective in order to reduce NOx in an exhaust gas in the above-mentioned usual gasoline internal combustion engine, therefore when fuel supply is premixing, as for the inflammable thin limitation of an air-fuel ratio, 22-25 are limitations.

[0006] Moreover, in some which carry out direct injection of the fuel and carry out jump spark ignition into a cylinder, although the thin limitation of an air-fuel ratio is expandable to 40-50, since mixed temper cloth is not homogeneous, there is a problem that there is fear of smoked generating.

[0007] Moreover, in the above-mentioned premixing autohesion fire internal combustion engine, in order to carry out autohesion fire, control of an ignition stage is very difficult and there is a problem that it is impossible for it to be stabilized especially in the latus load range, and to perform ignition stage control.

[0008] In view of the above-mentioned conventional trouble, this invention can complete combustion smoothly by the combustion start by the multipoint also with a thin air-fuel ratio, and it is efficient and it aims at offering low mpg, the internal combustion engine which can attain low emission, and its combustion start control method while being able to make a chemical reaction able to cause at a desired stage and being able to make combustion start.

[0009]

[Means for Solving the Problem] The internal combustion engine of this invention forms the gaseous mixture of elevated-temperature high pressure in the combustion chamber formed at a cylinder, the cylinder head, and a piston, and constitutes a combustion start means from a source of laser in which wavelength outputs the laser beam of the excitation band of OH basis or CH basis mostly in the internal combustion engine which burns a gaseous mixture.

[0010] The hydrocarbon in fuel is constituted by combination of two or more CH bases, if adiabatic compression of the gaseous mixture is carried out by the compression stroke and it becomes elevated-temperature high pressure, the so-called cracking decomposed into a molecule with the small molecular weight which the large hydrocarbon and large unsaturated hydrocarbon of molecular weight pyrolyze, and contains OH basis and CH basis will happen, and the fuel molecule decomposed in this way will carry out the combustion reaction of it. The combustion reaction is CnHm and O<sub>2</sub>. It reacts and is CO<sub>2</sub>. H<sub>2</sub>O and heat are generated, and in order to start the chain of this combustion

reaction, activation energy is usually given in the form of heat by jump spark ignition etc. Thus, although chain reaction is started after the number msec of after that by giving activation energy, luminescence of OH basis or CH basis is accepted in early stages of the chain reaction. Therefore, it understands that generating of OH radical or CH radical is making the chain of a combustion reaction start. Therefore, it understands that the chain of a combustion reaction can be made to start by generating these OH(s) radical and CH radical with any means.

[0011] OH radical and CH radical which are activity chemical species are generated directly, and chain reaction, i.e., combustion, is made to cause by this invention in this way by irradiating the laser beam of the wavelength of the excitation band, and exciting it to OH basis or CH basis.

[0012] Thus, although OH radical which is a combustion-control factor, and CH radical are generated, since energy is given and excited not in the form of heat energy but in the form of a light energy, 10-20mJ is enough as the light energy of the irradiated laser beam to which activation energy can be supplied very efficiently, and it is good in below the half of 40mJ(s) of the ignition energy by the conventional ignition plug. Moreover, a direct OH radical and CH radical are generated by laser beam irradiation, immediately, the chain of a combustion reaction can be made to be able to start and a lot of [ all at once ] OH radicals and CH radicals can be generated in the whole irradiation field of a laser beam.

[0013] Therefore, according to this invention, a desired stage can be made to start combustion steadily, degree of constant volume improves, while efficiency is high and can complete combustion smoothly also with a thin air-fuel ratio by the combustion start by the multipoint, the highest flame temperature falls, and low mpg and the efficient internal combustion engine of low emission can be attained.

[0014] In addition, although what also lights the former by the source of laser is proposed, it gives heat energy like an ignition plug, is outputting the heat energy of 1000-1500mJ, and an operation is also the same as usual and it does not do the above-mentioned operation so for it.

[0015] Moreover, the combustion start control method of the internal combustion engine of this invention Introduce a gaseous mixture in the cylinder by which the upper and lower sides were closed at the cylinder head and the piston which can be moved up and down, and a gaseous mixture is compressed by upper \*\* of a piston. It is that to which wavelength irradiates the laser beam of the excitation band of OH basis or CH basis mostly a compression top dead center or just behind it. While the gaseous mixture introduced within the cylinder is mixed equally, a bird clapper changes cracking into an elevated temperature and a high-pressure state by the compression stroke, and OH basis and CH basis are certainly generated over the whole gaseous mixture. irradiating a laser beam a compression top dead center or just behind it at the gaseous mixture -- above -- immediately -- or -- the chain reaction of combustion is started by the multipoint all at once in \*\* For this reason, degree of constant volume improves, efficiency is high, and flame propagation distance becomes short, combustion of it with a thin air-fuel ratio is attained, and the low NOx combustion of it benefits the combustion start by the multipoint possible.

[0016]

[Embodiments of the Invention] Hereafter, 1 operation gestalt of this invention is explained with reference to drawing 1 and drawing 2.

[0017] In drawing 1 (a), 1 is an internal combustion engine which uses a gasoline as fuel, and 2 is the cylinder head which the cylinder and 3 are wearing a piston, and 4 is wearing the upper surface of a cylinder 1, and forms a combustion chamber 5 between the piston 3 upper surfaces. 6 is the suction port formed in the cylinder head 4, and the inhalation-of-air bulb 7 which opens and closes opening 6a to the combustion chamber 5 of this suction port 6 is formed. The exhaust air bulb 9 which 8 is the exhaust air port formed in the cylinder head 4, and opens and closes opening 8a to the combustion chamber 5 of this exhaust air port 8 is formed. 10 is an injector which carries out injection supply of the fuel towards the stem base of the inhalation-of-air bulb 7 through a suction port 6. 11 is a source of laser as a combustion start means, and the crevice 12 for irradiating widely in a combustion chamber 5 the laser beam from the source 11 of laser is formed in the upper wall side which is arranged at the unilateral section which attends the combustion chamber 5 of the cylinder head 4, and forms a combustion chamber 5. The source 11 of laser outputs the laser beam of a near ultraviolet ray with a wavelength of about 310nm, and the laser beam of this wavelength can realize it by using the source of laser makes double precision frequency of a laser beam with a wavelength [ from helium-Ne laser ] of 632.8nm, and it was made to output it.

[0018] The arrangement composition of opening 6a of these suction ports 6, opening 8a of the exhaust air port 8, and the source 11 of laser and the irradiation field (it expresses as a slash) of a laser beam are shown in drawing 1 (b).

[0019] If operation by the above composition is explained, before the inhalation-of-air bulb 7 will open, the fuel of the specified quantity is injected from an injector 10, and premixing is performed. Next, while the inhalation-of-air bulb 7 opens by the intake stroke and a gaseous mixture is introduced in a cylinder 2, it is equally mixed within a cylinder 2. Subsequently, by an inlet valve's 7 closing, and a piston's 3 going up, and compressing a gaseous mixture, a gaseous mixture will be in an elevated temperature and a high-pressure state, and it will decompose into a molecule with the small molecular weight in which cracking arises and fuel contains OH basis and CH basis. in addition, a gaseous mixture [ in / a compression top dead center (TDC) / as the compression ratio at this time is

shown in drawing 2] -- rather than autohesion fire temperature, only deltaT is low, and temperature sets it up so that it may become the temperature which does not carry out autohesion fire and a laser beam with a wavelength of about 310nm irradiates in a combustion chamber 5 from the source 11 of laser just behind a compression top dead center (TDC) -- having -- the gaseous mixture in the irradiation field -- inner OH basis is excited and OH radical is generated That is, light with a wavelength of 310nm is the light of the excitation band of OH basis, and OH basis serves as OH radical with the reaction rate of about 10 to 9 secs by being given the light energy of this wavelength. In addition, 10-20mJ is enough as the light energy of the laser beam irradiated for this reaction. In this way, if a lot of OH radicals are generated, as the chain reaction of combustion starts immediately and it is shown in drawing 2 / a gaseous mixture will serve as temperature more than autohesion fire temperature at once, and the chain reaction of combustion will be started by the multipoint all at once. For this reason, degree of constant volume improves, efficiency is high, and flame propagation distance benefits the combustion start by the multipoint short, and combustion with a thin air-fuel ratio is attained, and the highest flame temperature falls, and low NOx combustion is realized.

[0020] In addition, although the above-mentioned explanation showed the example which generates OH radical by irradiating about 310nm laser beam and exciting OH basis, you may make it generate CH radical by irradiating about 430nm laser beam and exciting CH basis.

[0021] Moreover, before the inhalation-of-air bulb 7 opens with the above-mentioned operation gestalt, while injecting fuel from an injector 10 and forming premixed air within a suction port 6 Although the example of the internal combustion engine to which it is made to become the temperature in which a gaseous mixture does not carry out autohesion fire in a compression top dead center, a laser beam is irradiated at a desired stage, and it was made to carry out start fire of the combustion by the multipoint was shown Into an intake stroke, fuel is injected from an injector 10, a gaseous mixture is formed within a cylinder 2, the source 11 of laser to a laser beam is irradiated just behind a compression top dead center, and you may make it make it burn. Furthermore, it is also applicable also to the internal combustion engine which injected fuel in the compression stroke at the direct combustion chamber.

[0022]

[Effect of the Invention] In the internal combustion engine which according to the internal combustion engine of this invention the gaseous mixture of elevated-temperature high pressure is formed [ internal combustion engine ] in the combustion chamber formed at a cylinder, the cylinder head, and a piston as mentioned above, and burns a gaseous mixture Since wavelength constituted the combustion start means from a source of laser which outputs the laser beam of the excitation band of OH basis or CH basis mostly the gaseous mixture of elevated-temperature high pressure -- by irradiating the laser beam of the wavelength of the excitation band to inner OH basis or inner CH basis OH radical and CH radical which are a combustion-control factor very efficiently can be generated by few energy. immediately -- or -- \*\* -- Therefore, can make the chain of a combustion reaction start immediately, degree of constant volume improves, and efficiency is high. Moreover, OH radical and CH radicals can be generated all at once in the whole irradiation field of a laser beam. while flame propagation distance becomes short by the combustion start by the multipoint and being able to complete combustion smoothly also with a thin air-fuel ratio -- the highest flame temperature -- low -- it can do -- therefore, low mpg - it is efficient and low emission can be attained

[0023] Moreover, according to the combustion start control method of the internal combustion engine of this invention, introduce a gaseous mixture in the cylinder by which the upper and lower sides were closed at the cylinder head and the piston which can be moved up and down, and a gaseous mixture is compressed by upper \*\* of a piston. Since wavelength irradiates the laser beam of the excitation band of OH basis or CH basis mostly a compression top dead center or just behind it While the gaseous mixture introduced within the cylinder is mixed equally, a bird clapper changes cracking into an elevated temperature and a high-pressure state by the compression stroke, and OH basis and CH basis are certainly generated over the whole gaseous mixture. irradiating a laser beam a compression top dead center or just behind it at the gaseous mixture -- above -- immediately -- or -- the chain reaction of combustion is started by the multipoint all at once in \*\*, and the above-mentioned effect is demonstrated

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## DESCRIPTION OF DRAWINGS

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### [Brief Description of the Drawings]

[Drawing 1] The outline composition of 1 operation gestalt of the internal combustion engine of this invention is shown, (a) is drawing of longitudinal section and (b) is the plan of the arrangement composition of an important section.

[Drawing 2] It is the property view of a crank angle and temperature in this operation gestalt.

### [Description of Notations]

1 Internal Combustion Engine

2 Cylinder

3 Piston

4 Cylinder Head

5 Combustion Chamber

11 Source of Laser

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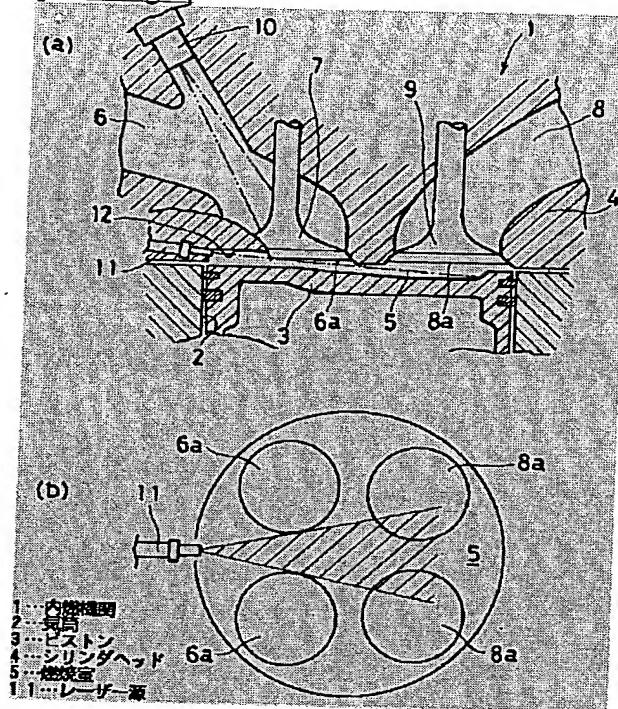
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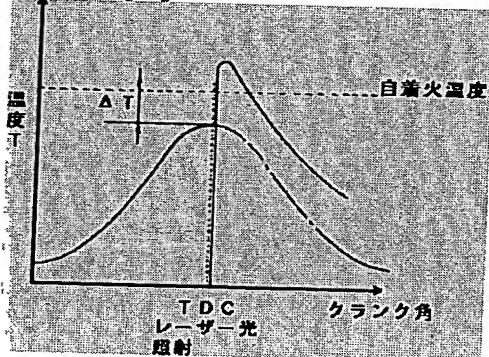
DRAWINGS

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[Drawing 1]



[Drawing 2]



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